

# MOVING PICTURE DECODING APPARATUS AND MOVING PICTURE DECODING METHOD

## BACKGROUND OF THE INVENTION

5       The present invention relates to a moving picture decoding apparatus, and especially, to a moving picture decoding apparatus capable of reducing a capacity of a frame memory when coded moving pictures are decoded.

10       Conventionally, this kind of a moving picture decoding apparatus is used as a method for reducing a frame memory capacity. As the conventional moving picture decoding apparatus, in JP-A-261635/1997 for example, as an arrangement for reducing a frame memory capacity necessary for storage of reference images and re-ordering decoded  
15       images, an arrangement is disclosed, which comprises a data compression circuit for compressing a decoded image and a data expansion circuit for expanding a compressed data. Also, in JP-A-247673/1997, an arrangement is proposed, in which a moving pictures data of which data  
20       content has been reduced by data content reducing means for reducing a data content of a decoded moving pictures data is stored in a frame memory, and a data content of a data read from the frame memory is restored by data content restoring means.

25       Also, in JP-A-4550/1998 for example, an apparatus is

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proposed, in which memory reduction is facilitated using Adaptive Differential Pulse Code Modulation (ADPCM). In the apparatus described in the publication, compression is conducted by estimating a change of each block of  $n \times m$  pixels compressed using orthogonal translation, encoding a first pixel of each block with  $p$  bits in accordance with the ADPCM, encoding an estimated value of the change with  $n \times h$  bits, and further, encoding a difference value between other each pixel following the first pixel and an average value of all pixels in the blocks with  $p-k$  bits.

However, in the conventional moving picture decoding apparatus proposed in the above-described JP-A-4550/1998 and so forth, of which objective is to reduce capacity of the frame memory, there is a task that efficient access to the memory cannot be realized.

The reason thereof is that an access width of the memory is not at all taken into account in a memory compression and expansion section of the above-described moving picture decoding apparatus.

#### SUMMARY OF THE INVENTION

The objective of the present invention is to solve the above-mentioned.

Also, the objective thereof is to provide a moving picture decoding apparatus for reducing capacity of a

frame memory necessary when an image is decoded by means of compression operation and accomplishing compression and expansion processing of a memory content with a high speed, and further, for decoding an image with high quality.

5 For solving the above-described objective, the moving picture decoding apparatus of the present invention, to which a compressed stream generated using an inter-frame prediction system is input, comprises compression means for compressing a decoded image when the signal is stored  
10 in a memory, expansion means for expanding a compressed image stored in the above-described memory, quantization means for controlling quantization on compression in the above-described compression means, and access width control means for controlling the above-described  
15 quantization control means so that an information content for a single or a plurality of memory compression processing units or for every control unit of memory compression processing is in conformity with the bit number of an access unit of the above-described memory.

20 In the moving picture decoding apparatus of the present invention, said access width control means comprises means for controlling said quantization control means so that the coded bit number for a single or a plurality of compression processing units or for every control unit of  
25 compression processing is in conformity with the bit

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number of an access unit of said storage means in case that the coded bit number exceeds the bit number of an access unit of said storage means or is lacking.

Furthermore, in the moving picture decoding apparatus of the present invention, said compression means and expansion means conduct compression and expansion, respectively, in accordance with a pixel difference prediction encoding system.

Furthermore, the moving picture decoding apparatus of the present invention further comprising a plurality of quantizers and a plurality of quantization characteristic tables.

Furthermore, the moving picture decoding apparatus of the present invention further comprising a plurality of quantizers and a quantization characteristic table being shared by said plurality of quantizers.

Furthermore, in the moving picture decoding apparatus of the present invention, said compression means and expansion means conduct compression and expansion, respectively, in accordance with an orthogonal translation encoding system.

Furthermore, in the moving picture decoding apparatus of the present invention, said access width control means conducts control using information included in the compressed stream.

Furthermore, in the moving picture decoding apparatus of the present invention, said storage means is a frame memory.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

This and other objects, features and advantages of the present invention will become more apparent upon a reading of the following detailed description and drawings, in which:

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Fig. 1 is a block diagram showing an arrangement of a moving picture decoding apparatus of the first embodiment of the present invention;

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Fig. 2 is a view for explaining the principle of the present invention and a view for showing an access bit width and a width of a quantized data;

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Fig. 3 is a view for explaining the principle of the present invention and a view for showing an access bit width and a width of a quantized data;

Fig. 4 is a view for showing an arrangement of a memory compression and expansion section in the first embodiment of the present invention and

Fig. 5 is a block diagram showing an arrangement of the second embodiment of the present invention.

#### DESCRIPTION OF THE EMBODIMENTS

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A form of working of the present invention will be

explained. In a preferable form of working of a moving picture decoding apparatus in the present invention, compression is applied to a decoded image in a memory compressor (105 of Fig. 1), and it is stored in a frame memory (106 of Fig. 1). Based on an occupied content of the frame memory (106 of Fig. 1), in case that the coded data bit number for a single or a plurality of memory compression processing units or for every control unit of memory compression processing exceeds the bit number of a memory access unit or is lacking, a memory access width control section (110 of Fig. 1) applies control to a quantizer control section (109 of Fig. 1) so that the coded data bit number is conformed to be equal to or less than the bit number of the memory access unit.

First, the principle of the present invention will be explained. A decoded image is compressed using various compression methods. However, the coded data bit number per compression processing unit, which is allocated by compression operation, is allocated based on a compression ratio, and the bit number of a memory access unit is not taken into account.

It is assuming that the bit number of the memory access unit is  $M1$  bits, the coded data bit numbers of a compression processing unit, which is allocated based on a compression ratio, are  $N1$ ,  $N2$ ,  $N3$ , ...  $Nn$ , respectively,

and  $M1 < N1 + N2 + \dots + Nn$ . In this case, a coded data of  $n$  blocks cannot be extracted through one access.

Accordingly, by decreasing the bit number allocated by  $N1 + N2 + \dots + Nn$  by  $N1 + N2 + \dots + Nn - M1$ , an allocated bit can be made equal to or less than  $M1$ , and therefore, the coded data can be taken out through one access.

An example of  $n = 3$  as the  $n$  blocks is shown in Fig. 2. By subtracting more than or equal to  $M2$  ( $M2 = (N1 + N2 + N3) - M1$ ) bits from  $N1 + N2 + N3$  bits, an allocated bit can be made equal to or less than  $M1$ .

On the other hand, as shown in Fig. 3, in case that the allocated bit is less than the bit number  $M1$  of a memory access unit, and a frame memory has capacity, allocation of the bit number of the coded data can be also increased.

In the present invention, on the basis of such a principal, the memory access width control section (110 of Fig. 1) applies control of an access width of the frame memory to the quantization control section.

In a from of working of the present invention, the memory compressor and memory expander may have an arrangement in which compression and expansion are conducted, respectively, in accordance with DPCM.

In a from of working of the present invention, based on access width information from the access width control section, in case that a generated information content for

5 a single or a plurality of memory compression processing  
units or for every control unit of memory compression  
processing exceeds the bit number of a memory access unit,  
quantization control is conducted by preparing a plurality  
of quantizers having different quantization  
characteristics, and a quantization table, and by  
selecting a quantizer that is adapted to an access width.  
In this case, an arrangement may be adopted, in which one  
quantization table is shared by the plurality of  
10 quantizers having different quantization characteristics.  
In other words, by variably changing a reference interval  
of one quantization table in accordance with an obtained  
quantization characteristic (resolution and so forth), it  
is possible to obtain the different quantization  
15 characteristics while one quantization table is shared.

Also, in a form of working of the present invention, the  
memory compressor and the memory expander may conduct  
compression and expansion, respectively, in accordance  
with an orthogonal translation encoding system.

20 Moreover, in a form of working of the present invention,  
the access width control section may apply access width  
control to the quantization control section using  
information included in the compressed stream. Below, a  
detailed explanation will be made in accordance with an  
25 embodiment.



The first embodiment of the present invention will be explained in detail by referring to drawings. Fig. 1 is a view showing an arrangement of one embodiment of the present invention.

Referring to Fig. 1, this embodiment is constructed by comprising a variable length decoder 101, an inverse quantizer 102, an inverse discrete cosine transducer (Inverse DCT) 103, an adder 104, a motion compensation section 108, and a memory compression and expansion section 11. The memory compression and expansion section 11 is constructed by comprising a memory compressor 105, a frame memory 106, a memory expander 107, a quantizer control section 109, and a memory width control section 110.

A compressed moving pictures stream encoded by a system such as an ISOIS13818-2 (MPEG-2VIDEO) is supplied as an input to the variable length decoder 101.

The variable length decoder 101 performs variable length decoding, and supplies a result thereof to the inverse quantizer 102.

The inverse quantizer 102 performs inverse quantization, and supplies a result thereof to the inverse discrete cosine transducer 103.

The inverse discrete cosine transducer 103 transduces a conversion coefficient into an image, and supplies a

result thereof to the adder 104.

The adder 104 performs addition of the image supplied from the inverse discrete cosine transducer 103 and a predicted image supplies from the motion compensation section 108, and supplies a result thereof to the memory compression and expansion section 11.

The memory compression and expansion section 11 applies compression and expansion operation to a decoded image, and supplies it to the motion compensation section 108.

The motion compensation section 108 performs motion compensation based on a motion vector supplied from the variable length decoder 101 and the image supplied from the memory compression and expansion section 11, and supplies the predicted image to the adder 104.

The memory compressor 105 of the memory compression and expansion section 11 applies compression to the image supplied from the adder 104, and stores it in the frame memory 106.

The memory expander 107 extracts the compressed image from the frame memory 106 and expands it, and supplies it to the motion compensation section 108.

The quantization control section 109 applies control for quantization of the image to the memory compressor 105 and the memory expander 107.

The access width control section 110 applies control to

the quantization control section 109 using information of the frame memory 106 so that an information content for a single or a plurality of memory compression processing units or for every control unit of memory compression processing is conformed to be equal to or less than the bit number of a memory access unit.

As the compression encoding in the memory compressor and the memory expander, pixel difference encoding, adaptive pixel difference encoding, DCT translation, Hadamard translation, and Wavelet translation and so forth, for example, are used.

Fig. 4 is a view showing one example of an arrangement of the memory compression and expansion section 11 in one embodiment of the present invention in case that the memory compressor 105 and the memory expander 107 are constructed of the pixel difference encoding. The memory compressor 105 and the memory expander 107 in Fig. 1 correspond to a memory compressor 21 and a memory expander 23 in Fig. 4.

Referring to Fig. 4, the memory compressor 21 is constructed by comprising a subtracter 201, a quantizer 202, a fixed-length <sup>mode</sup> decoder 203, an inverse quantizer 204, an adder 205, and a predictor 206. The memory expander 23 is constructed by comprising a fixed-length decoder 207, an inverse quantizer 208, an adder 209, and a predictor

An image to be compressed is supplied to the subtracter 201 as an input, and the subtracter 201 performs subtraction of this input signal and a predicted value supplied from the predictor 206, and supplies a prediction error to the quantizer 202.

The fixed-length decoder 203 encodes the quantized value and stores it in the frame memory 22. In the inverse quantizer 204, the adder 205 and the predictor 206, inverse quantization and local decoding are performed, and an output from the predictor 206 is supplied to the subtracter 201.

The memory access width control section 25 takes account of a compression ratio based on an occupied ratio of the frame memory 22, and applies bit allocation control to the quantization control section 24, which is in conformity with the bit number of a memory access unit.

The quantization control section 24 performs quantization control in which memory access width information is added, and applies control to the quantizer 202 so that an information content generated for a single

or a plurality of memory compression processing units or for every control unit of memory compression processing is to be equal to or less than the bit number of a memory access unit.

5        In this embodiment, if the compression processing unit is assumed to be constant, a block of a single pixel or a plurality of  $m \times n$  pixels becomes to be a compression processing unit.

10        The memory expander 23 receives a compressed image from the frame memory 22, and performs expansion of the compressed image by applying expansion and inverse quantization thereto, and outputs the image.

15        Next, an example will be explained, in which one memory access width control is realized. One quantizer having a fixed compression ratio is used for quantization of a prediction error. In such a case, in case that an information content generated for a single or a plurality of memory compression processing units or for every control unit of memory compression processing exceeds the  
20        bit number of a memory access unit, a plurality of quantizers are prepared, and control is conducted so that the information content is in conformity with an access width. In this example, since an occupied content of the frame memory can be fixed, information from the frame  
25        memory is not required. In addition, an arrangement can be

adopted, in which a plurality of quantizers having quantization characteristics different from each other share one quantization characteristic table.

On the other hand, in a case of orthogonal translation and so forth, it is difficult to fix an information content generated for a single or a plurality of memory compression processing units or for every control unit of memory compression processing. In such a case, use of an occupied content of the frame memory is convenient.

Next, the second embodiment of the present invention will be explained. In the above-described first embodiment, the access width control section 110 conducts control of the quantizer control section 109 using the access memory width and the occupied content of the frame memory.

Fig. 5 is a view showing an arrangement of the second embodiment of the present invention. Referring to Fig. 5, in the second embodiment of the present invention, the access width control section 110 receives information from the inverse quantizer 102, and applies control to the quantization control section 109, in which information included in a compressed stream is added, in other words, in which information during quantization is added. Accordingly, by taking account of the information of the compressed stream and a relation between positions on an image, and so forth, allocation of the information content

can be realized, which makes image quality be improved.

As explained above, in accordance with the present invention, advantages are effected as described below.

5 The first advantage of the present invention is that compression and expansion processing for the contents of the memory can be conducted with a high speed.

10 The reason thereof is that, in the present invention, since quantization control which is to be equal to or less than the number of bits of a memory access unit is conducted, the number of a memory access to the compressed image necessary for the expansion is reduced.

15 The second advantage of the present invention is that, by conducting allocation control of an information content using the information included in the compressed stream, an error of an pixel can be suppressed and image quality can be improved.

20 The reason thereof is that, in the present invention, by taking account of the information of the compressed stream and a relation between positions on an image, and so forth, allocation of the information content can be realized, which makes image quality be improved.